## *The Rotation Period of the Planet Saturn.* By G. W. Hough.

The white spot first observed by Professor E. E. Barnard on June 15 was a conspicuous object during the month of July.

I secured an observation on June 27, but supposed for some time that it was another spot, since I imagined the rotation period would not differ very materially from that found by Professor Asaph Hall in 1877. Owing to the low altitude of the planet, combined with much cloudy weather and poor seeing, but few observations of spots were secured.

At my request Professor S. W. Burnham made micrometer measures of spots on *Saturn* with the 40-inch telescope of the Yerkes Observatory, which he has kindly communicated to me.

I found the Barnard spot had been observed on three nights by myself and on two nights by Burnham, covering a period of fifty-three days, or 119 rotations. I have also reduced a micrometer observation by Professor Barnard made on June 23 (*Astronomical Journal*, pp. 542, 543). The time given by the micrometer differs 6·8 minutes from that adopted by the observer as the most probable value.

It is to be regretted that astronomers generally have not used the micrometer to ascertain the time of passage of the spot over the central meridian of the disc in place of a single estimation. For about twenty minutes of time, when the spot is near the central meridian, the motion may be regarded as uniform, and the time of passage over the central meridian may be ascertained by micrometer measures without taking into account the size of the disc, the latitude of the object, or the rotation period.

At mean distance one minute of rotation time is equal to $0''\cdot087$ of arc. Hence one should expect a large accidental error from an eye estimate.

With the micrometer, on the contrary, one can make as many measures as is desirable, any one of which is of far greater value than an eye estimate.

Besides the principal spot there were others which were not so well defined.

The following notation is used :—

$t$ = mean time of observation (six hours slow of Greenwich).

$m$ = distance from the central meridian, reduced to mean distance.

$\Delta t$ = reduction to the central meridian.

T = time of passage of the spot over the central meridian of the disc.

The constants for reduction were computed by using Barnard's value of the size of the disc, viz. $a = 8''\cdot90$, $b = 8''\cdot12$ (*A.N.* No. 3760).

In determining rotation period the observations have been corrected for motion in longitude, annual parallax, and aberration time.

*Micrometer Measures, Barnard Spot.*

| Date 1903. | *t* h m | *m* ″ | Δ*t* m | T h m | App. Disc. ″ | Obs. |
|---|---|---|---|---|---|---|
| June 23 | 15 03·0 | +2·68 | +32·2 | 15 35·2 | +2·63 | Bar. |
| 27 | 14 45·3 | +2·75 | +33·0 | 15 18·3 | ... | ... |
| | 56·9 | +1·86 | +22·2 | 19·1 | +2·74 | ... |
| Mean | ... | ... | ... | 15 18·7 | ... | Ho. |
| July 13 | 14 17·0 | −0·13 | − 1·6 | 14 15·4 | ... | ... |
| | 20·7 | −0·47 | − 5·4 | 15·3 | +2·69 | ... |
| Mean | ... | ... | ... | 14 15·3 | ... | Ho. |
| 18 | 12 11·0 | −2·61 | −31·3 | [11 39·7] | +2·98 | Ho. |
| 29 | 13 27·0 | −0·51 | − 6·1 | 13 20·9 | +2·90 | β |
| Aug. 19 | 9 58·0 | −2·24 | −26·8 | 9 31·2 | [+1·55] | β |

*Minor Spots.*

| Date 1903. | *t* h m | *m* ″ | Δ*t* m | T h m | App. Disc. ″ | Obs. |
|---|---|---|---|---|---|---|
| July 6 | 13 38·9 | −4·02 | −49·5 | 12 49·4 | +3·54 | Ho. |
| 22 | 12 42·2 | −2·99 | −36·2 | 12 06·0 | +1·31 | β |
| 23 | 11 26·1 | +0·13 | + 1·5 | 11 27·6 | ... | ... |
| | 34·2 | −0·50 | − 5·8 | 28·4 | +0·68 | β |
| Mean | ... | ... | ... | 11 28·0 | ... | ... |
| 23 | foll. spot | +2·42 | +29·0 | 11 57·0 | ... | β |
| 30 | 11 20·0 | +0·54 | + 6·5 | 11 26·5 | ... | β |
| Aug. 9 | 10 59·3 | −0·11 | − 8·3 | 10 51·0 | ... | Ho. |
| | foll. spot | +3·41 | +41·6 | 11 32·6 | ... | Ho. |
| 20 | 9 24·2 | −2·44 | −29·2 | 8 55·0 | ... | Ho. |
| 20 | 9 31·0 | +0·12 | + 1·3 | 9 32·3 | ... | Ho. |

July 18.—Seeing very bad; approximate.
Aug. 19.—Spot faint and difficult.

By combining the observation of June 27 with the following ones successively we get for the rotation period—

| d. | | h m s |
|---|---|---|
| 0 to 16 | R = | 10 38 19·0 |
| 0 „ 32 | | 26·1 |
| 0 „ 53 | | 29·0 |

These values indicate that the rotation period was not constant.

I have shown that the rotation periods for spots in the planet *Jupiter* are a function of the time, and are sensibly constant only for short intervals.

The following table shows the comparison of the observations with an ephemeris :—

First, for a uniform rotation period

$$R_1 = 10^h\ 38^m\ 27^s$$

and, secondly, for an increasing period

$$R_2 = 10^h\ 38^m\ 18^s + n \times 0^s{\cdot}1856$$

$n$ =, the number of rotations since June 27.

$$R_1 = \overset{h}{10}\ \overset{m}{38}\ \overset{s}{27}$$

$$R_2 = 10\ 38\ 18 + n \times \overset{s}{0{\cdot}1856}$$

| Date 1903. | Obs. | Days. | T. | O−E₁. m | O−E₂. m |
|---|---|---|---|---|---|
| June 23 | Bar. | −4 | 15 35·2 | + 1·8 | +0·4 |
| 27 | Ho. | 0 | 15 18·7 | + 0·0 | −0·3 |
| July 13 | Ho. | 16 | 14 15·3 | − 4·8 | −1·7 |
| 18 | Ho. | 21 | [11 39·7] | [+15·5] | ... |
| 29 | β | 32 | 13 20·9 | − 1·1 | +1·4 |
| Aug. 19 | β | 53 | 9 31·2 | + 4·1 | −0·2 |

The constant period satisfies the observations with a mean residual $(O-E_1) \neq 2^m{\cdot}3$, or a probable error on rotation period $\neq 1^s{\cdot}1$.

For the variable period the mean residual $O-E_2$ is $\neq 0^m{\cdot}8$, which is better than one ought to expect from the difficulty of the observations.

The kronocentric latitude of the spot was deduced from the measures made on June 27 and July 13, viz. $+36° 33'$ and $+36° 22'$ respectively.

The mean of the two values was adopted in the reduction of the observations.

The spots observed on July 6, 22, and 30 are identical. The rotation period for this spot is $10^h\ 38^m\ 30^s{\cdot}5 \neq 3^s{\cdot}2$.

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